ANALYSIS AND DESIGN OF THE SYMMETRICAL BUILDING WITH CONSIDERING DYNAMIC POUNDING EFFECT IN RESIDENTIAL APARTMENTS

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Abstarct: Major seismic events during the past decade such as those that have occurred in Northridge, Imperial Valley (May 18,1940),California (1994) Kobe, Japan (1995), Turkey (1999),Taiwan (1999) and Bhuj, Central western India (2001) have continued to demonstrate the destructive, Power of earthquakes, with destruction of engineered buildings, bridges industrial and port facilities as well as giving rise to great economic losses. Among the possible structural damages. Seismic Induced pounding has been commonly observed in several earthquake. As a result, a parametric study on buildings pounding response as well as proper seismic hazard mitigation practice for adjacent building is carried out. Therefore, the needs to improve seismic performance of the built environment through the development of performance oriented procedures have been developed. To estimate the seismic demands, nonlinearities in the structure are to be considered when the structures enters into inelastic range during devastating earthquake. Despite the increase in the accuracy and efficiency of the computational tools related to dynamic inelastic analysis, engineers, tend to adopt simplified non-linear dynamic analysis when evaluating seismic demands. This is due to problems related to its complexities and suitability for practical design applications. The time history analysis is a nonlinear procedure that can be used to estimate dynamic Needs imposed on a structure by earthquake ground motions. This project entitled", design and analysis of the symmetrical building with considering dynamic pounding effect in residential apartments "aims at studying seismic gap between adjacent buildings by dynamic analysis in etabs.

The effect of impact is studied using linear and non linear contact force on models for different separation distances and compared with normal model without pounding consideration. Pounding produces acceleration and shear at various story levels that are greater than those obtained from The no pounding case, while the peak drift depends on the input excitation characteristics. Also increasing gap width is likely to be effective when the separation is sufficiently wide practically to eliminate contact. If buildings separations in metropolitan areas four, to be deficient to prevent poundings, than there should be some cost-effective retrofitting methods to mitigate structural Use of shear wall, bracing system friction dampers are possible mitigation techniques.

The project briefly describes the seismic pounding effect on the same two symmetrical apartment buildings (G+15) with the gaps of 20 mm and 25 mm was considered for designed and analyzed for the dynamic and lateral loadings on the structure with the commercial software like ETABS was used in this thesis and comparing the results with storey drifts , storey shear , storey moments, and storey over turning moments are compared .

KEY WORDS : ETABS, Seismic pounding effect, storey moments, storey shear , storey overturning moments , etc,.

I.INTRODUCTION

Adjacent buildings with insufficient separation, having different dynamic characteristics may vibrate out of phase during earthquakes causing pounding between them. The pounding of structures may lead to severe damage and even result in complete collapse. Seismic pounding damage was found to be significant between adjacent buildings during the 1985 Mexico, 1994 Northridge, 1995 Kobe, 1999 Kocaeli and 2008 Sichuan earthquakes. The concentrated local damage and increased floor accelerations in buildings are some of the major consequences of seismic pounding.

The seismic pounding of structures is studied through numerical simulations, focusing on multi-story reinforced concrete (RC) buildings. The buildings are designed according to ACI-318-08. Three dimensional frame models of buildings are used where RC members are modeled as force-based elements with fiber-based section discretization. Material as well as geometric nonlinearities are considered . Nonlinear transient analysis is carried out for different earthquake records, configurations of buildings and gap sizes. The response of buildings is compared in terms of damage, pounding scenarios, impact forces, shear amplification factors and inter-story drift demands. For example, number of pounding instances can be observed from the horizontal displacement time history at a typical impact level between adjacent buildings. Future directions in the study include further development of contact-element models to capture the pounding phenomenon with greater accuracy, pounding analysis of base isolated tall buildings and non-structural loss estimation in the buildings.

Seismic Pounding Effect between Buildings

Pounding is one of the main causes of severe building damages in earthquake. The non-structural damage involves pounding or movement across separation A separation joint is the distance between two different building structures – often . two wings of the same facility– that allows the structures to move independently of one another.

A seismic gap is a separation joint provided to accommodate relative lateral movement during an earthquake. In order to provide functional continuity between separate wings, building utilities must often extend across these building separations, and architectural finishes must be detailed to terminate on either side. The separation joint may be only an inch or two in older constructions or as much as a foot in some newer buildings, depending on the expected horizontal movement, or seismic drift. Flashing, piping, fire sprinkler lines, HVAC ducts, partitions, and flooring all have to be detailed to accommodate the seismic movement expected at these locations when the two structures move closer together or further apart. Damage to items crossing seismic gaps is a common type of earthquake damage. If the size of the gap is insufficient, pounding between adjacent buildings may result in damage to structural components the buildings.

Required Seismic Separation Distance to Avoid Pounding

Bureau of Indian Standards clearly gives in its code IS 4326 that a Separation distance is to be provided between buildings to avoid collision during an earthquake. The code is mentions in following Table 1

Sl. No.	Type of Constructions	Gap Width/Storey, in mm for Design Seismic Coefficient αh =0.1
1	Box system or frames with shear walls	15.0
2	Moment resistant reinforced concrete frame	20.0
3	Moment resistant steel frame	30.0

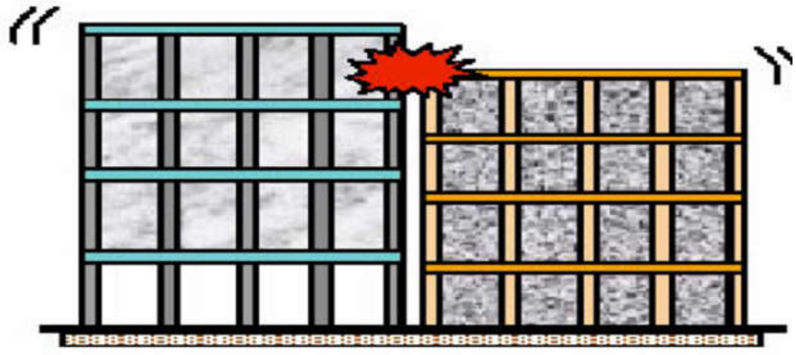
Investigations of past and recent earthquake damage have illustrated that the building structures are vulnerable to severe damage and/or collapse during moderate to strong ground motion. An earthquake with a magnitude of six is capable of causing severe damages of engineered buildings, bridges, industrial and port facilities as well as giving rise to great economic losses.

Several destructive earthquakes have hit Egypt in both historical and recent times from distant and near earthquakes. The annual energy release in Egypt and its vicinity is equivalent to an earthquake with magnitude varying from 5.5 to 7.3. Pounding between closely spaced building structures can be a serious hazard in seismically active areas. Investigations of past and recent earthquakes damage have illustrated several instances of pounding damage in both building and bridge structures. Pounding damage was observed during the 1985 Mexico earthquake, the 1988 Sequenay earthquake in Canada, the 1992 Cairo earthquake, the 1994 Northridge earthquake, the 1995 Kobe earthquake and 1999 Kocaeli earthquake. Significant pounding was observed at sites over 90 km from the epicenter thus indicating the possible catastrophic damage that may occur during future earthquakes having closer epicenters. Pounding of adjacent buildings could have worse damage as adjacent buildings with different dynamic characteristics which vibrate out of phase and there is insufficient separation distance or energy dissipation system to accommodate the relative motions of adjacent buildings. Past seismic codes did not give definite guidelines to preclude pounding, because of this and due to economic considerations including maximum land usage requirements, especially in the high density populated areas of cities, there are many buildings worldwide which are already built in contact or extremely close to another that could suffer pounding damage in future earthquakes. A large separation is controversial from both technical (difficulty in using expansion joint) and economical loss of land usage) views. The highly congested building system in many metropolitan cities constitutes a major concern for seismic pounding damage.For these reasons, it has been widely accepted that pounding is an undesirable phenomenon that should be prevented or mitigated zones in connection with the corresponding design ground acceleration values will lead in many cases to earthquake actions which are remarkably higher than defined by the design codes used up to now. The most simplest and effective way for pounding mitigation and reducing damage due to pounding is to provide enough separation but it is sometimes difficult to be implemented due to detailing problem and high cost of land. An alternative to the seismic separation gap provision in the structure design is to minimize the effect of pounding through decreasing lateral motion which can be achieved by joining adjacent structures at critical locations so that their motion could be in-phase with one another or by increasing the pounding buildings damping capacity by means of passive structural control of energy dissipation system or by seismic retrofitting.

Seismic Pounding Effect between Buildings

Pounding is one of the main causes of severe building damages in earthquake. The non-structural damage involves pounding or movement across separation joints between adjacent structures. Seismic pounding between two adjacent buildings occur

- during an earthquake
- different dynamic characteristics
- adjacent buildings vibrate out of phase
- at-rest separation is insufficient



Seismic Pounding between Adjacent Buildings

Response Spectrum Analysis

The response spectrum technique is really a simplified special case of modal analysis. The modes of vibration are determined in period and shape in the usual way and the maximum response magnitudes corresponding to each mode are found by reference to a response spectrum. The response spectrum method has the great virtues of speed and cheapness. The basic mode superposition method, which is restricted to linearly elastic analysis, produces the complete time history response of joint displacements and member forces due to a specific ground motion loading There are two major disadvantages of using this approach. First, the method produces a large amount of output information that can require an enormous amount of computational effort to conduct all possible design checks as a function of time. Second, the analysis must be repeated for several different earthquake motions in order to assure that all the significant modes are excited, since a response spectrum for one earthquake, in a specified direction, is not a smooth function.

There are significant computational advantages in using the response spectra method of seismic analysis for prediction of displacements and member forces in structural systems. The method involves the calculation of only the maximum values of the displacements and member forces in each mode using smooth design spectra that are the average of several earthquake motions. In this analysis, the CQC method to combine these maximum modal response values to obtain the most probable peak value of displacement or force is used. In addition, it will be shown that the SRSS and CQC3 methods of combining results from orthogonal earthquake motions will allow one dynamic analysis to produce design forces for all members of the structure.

OBJECTIVE OF THE STUDY

- Identify the structural response of adjacent buildings with different layouts
- To conduct the response spectrum analysis of the structure with different gap widths with the adjacent structure.
- To find the storey displacement, and building torsion etc to be studied and compared with the models

- To compare the seismic effect of the buildings with gaps of 20 mm and 25 mm with rectangle shaped buildings are compared .

II.LITERATURE REVIEW

Viviane Warnotte summarized basic concepts on which the seismic pounding effect occurs between adjacent buildings. He identified the conditions under which the seismic pounding will occur between buildings and adequate information and, perhaps more importantly, pounding situation analyzed. From his research it was found that an elastic model cannot predict correctly the behaviors of the structure due to seismic pounding. Therefore non-elastic analysis is to be done to predict the required seismic gap between buildings.

Robert Jankowski addressed the fundamental questions concerning the application of the nonlinear analysis and its feasibility and limitations in predicting seismic pounding gap between buildings. In his analysis, elastoplastic multi-degree-offreedom lumped mass models are used to simulate the structural behavior and non-linear viscoelastic impact elements are applied to model collisions. The results of the study prove that pounding may have considerable influence on behavior of the structures.

Shehata E. Abdel Raheem developed and implemented a tool for the inelastic analysis of seismic pounding effect between buildings. They carried out a parametric study on buildings pounding response as well as proper seismic hazard mitigation practice for adjacent buildings. Three categories of recorded earthquake excitation were used for input. He studied the effect of impact using linear and nonlinear contact force model for different separation distances and compared with nominal model without pounding consideration.

III.STRUCTUTRAL DETAILS

Structural Members

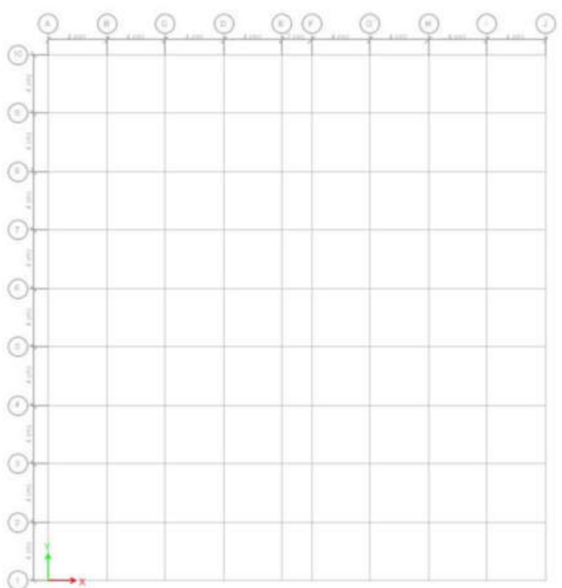
Thickness of one way slab	0.150 m
Beam	0.45*0.50m
Column	0.55*0.45m

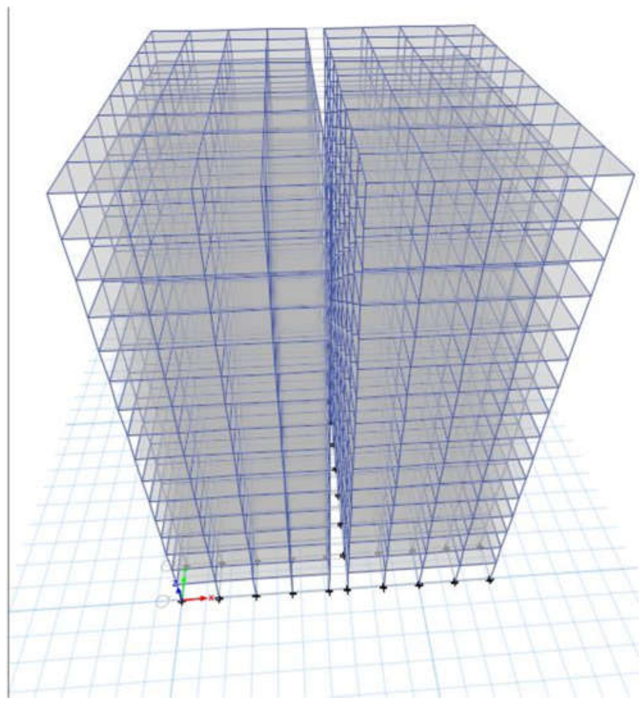
Material properties

Grade of Concrete	M40
Grade of Steel	Fe 415
Young's Modulus of concrete	31622.77
Young's modulus of steel	20000
Poisons ratio	0.3
Density of concrete	25 Kn/m^3
Density of steel	76.98 Kn/m^3
Bearing capacity of soil	200 Kn/m^2

Details of Buildings

Utility of Building	Residential building
Number of storey	G+15
Storey Height	48.5 m
No of Bays	10X 10 bays
Building adjacent space	20 mm
Building shape	Rectangle
Bay width along X-direction	3
Bay width along Y-direction	3
Seismic Zone	5
Soil type	Medium(Type 2)
Response reduction factor	5
Importance factor	1.0
Damping of Structures	5%

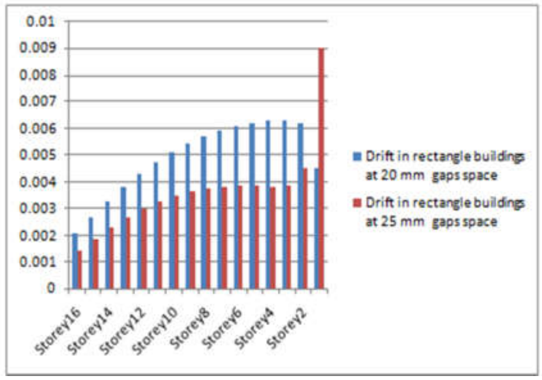




IV.RESULTS

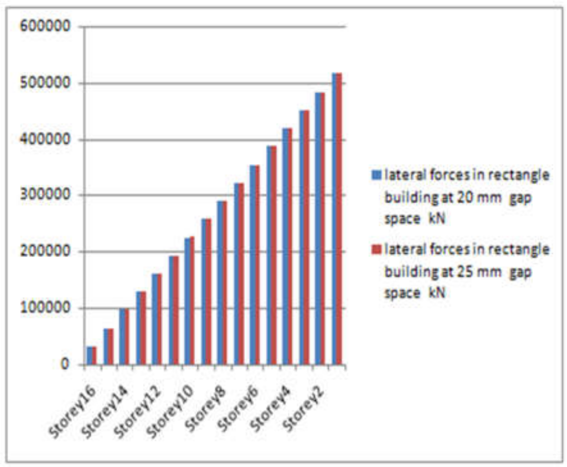
EQUVILAENT STATIC ANALYSIS

Storey	Load Case/Combo	Drift in rectangle buildings at 20 mm gaps space	Drift in rectangle buildings at 25 mm gaps space
Storey16	static	0.00209	0.00148
Storey15	static	0.00268	0.00192
Storey14	static	0.00329	0.00235
Storey13	static	0.00384	0.00273
Storey12	static	0.00433	0.00305
Storey11	static	0.00476	0.00331
Storey10	static	0.00513	0.00352
Storey9	static	0.00545	0.00368
Storey8	static	0.00571	0.00379
Storey7	static	0.00593	0.00386
Storey6	static	0.0061	0.00388
Storey5	static	0.00623	0.00388
Storey4	static	0.00631	0.00385
Storey3	static	0.00633	0.00389
Storey2	static	0.0062	0.00452
Storey1	static	0.00454	0.00907



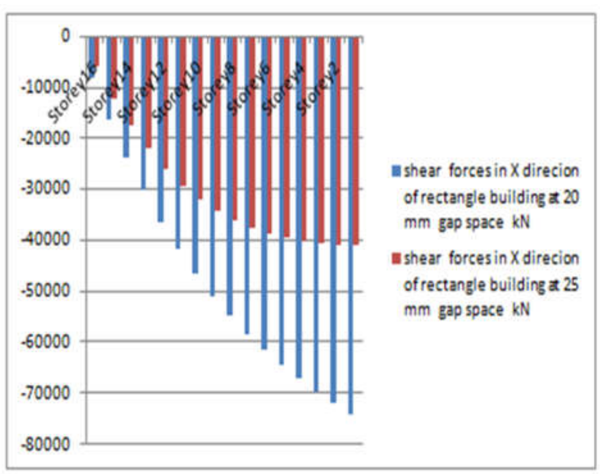
LATERAL FORCES (P)

Storey	Load Case/Combo	lateral forces in rectangle building at 20 mm gap space	lateral forces in rectangle building at 25 mm gap space
		kN	kN
Storey16	static	32193.18	32197.2
Storey15	static	64386.35	64394.4
Storey14	static	96579.53	96591.6
Storey13	static	128772.7	128788.8
Storey12	static	160965.9	160986
Storey11	static	193159.1	193183.2
Storey10	static	225352.2	225380.4
Storey9	static	257545.4	257577.6
Storey8	static	289738.6	289774.8
Storey7	static	321931.8	321972
Storey6	static	354124.9	354169.2
Storey5	static	386318.1	386366.4
Storey4	static	418511.3	418563.6
Storey3	static	450704.5	450760.8
Storey2	static	482897.6	482958
Storey1	static	516170.7	516235.2



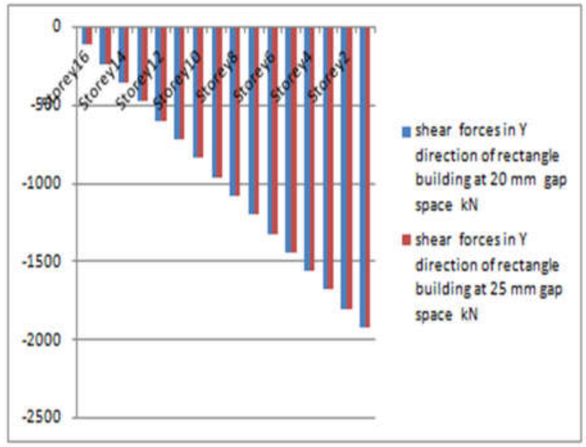
3 SHEAR FORCE IN X DIRECION

Storey	Load Case/Combo	shear forces in X direction of rectangle building at 20 mm gap space	shear forces in X direction of rectangle building at 25 mm gap space
		kN	kN
Storey16	static	-8136.78	-6064.93
Storey15	static	-16266.8	-12123.2
Storey14	static	-23639.9	-17424.1
Storey13	static	-30307.5	-22019.5
Storey12	static	-36321.4	-25960.9
Storey11	static	-41733	-29299.9
Storey10	static	-46594.1	-32088.2
Storey9	static	-50956.3	-34377.4
Storey8	static	-54871.1	-36219.1
Storey7	static	-58390.2	-37665
Storey6	static	-61565.2	-38766.7
Storey5	static	-64447.7	-39575.8
Storey4	static	-67089.4	-40144
Storey3	static	-69541.8	-40522.9
Storey2	static	-71856.5	-40764
Storey1	static	-74086	-40919.9



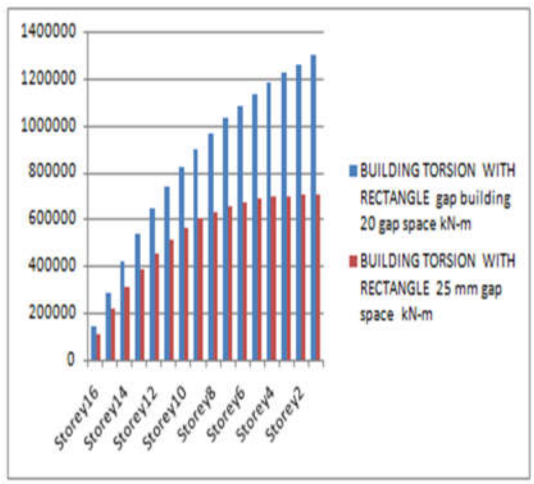
SHEAR FORCE IN Y DIRECION

Storey	Load Case/Combo	shear forces in Y direction of rectangle building at 20 mm gap space	shear forces in Y direction of rectangle building at 25 mm gap space
		kN	kN
Storey16	static	-120	-120
Storey15	static	-240	-240
Storey14	static	-360	-360
Storey13	static	-480	-480
Storey12	static	-600	-600
Storey11	static	-720	-720
Storey10	static	-840	-840
Storey9	static	-960	-960
Storey8	static	-1080	-1080
Storey7	static	-1200	-1200
Storey6	static	-1320	-1320
Storey5	static	-1440	-1440
Storey4	static	-1560	-1560
Storey3	static	-1680	-1680
Storey2	static	-1800	-1800
Storey1	static	-1920	-1920



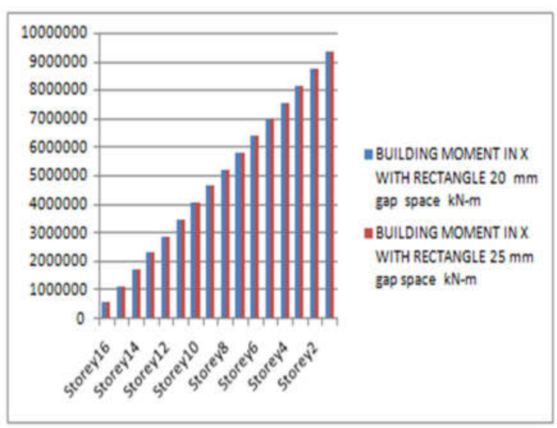
BUILDING TORSION

Storey	Load Case/Combo	BUILDING TORSION WITH RECTANGLE gap building 20 gap space	BUILDING TORSION WITH RECTANGLE 25 mm gap space
		kN-m	kN-m
Storey16	static	144302	106978.8
Storey15	static	288483.2	213836.7
Storey14	static	419038	307064.3
Storey13	static	536895.4	387590.7
Storey12	static	642984.6	456345.4
Storey11	static	738234.6	514257.7
Storey10	static	823574.4	562256.9
Storey9	static	899933.2	601272.4
Storey8	static	968240	632233.6
Storey7	static	1029424	656069.8
Storey6	static	1084414	673710.3
Storey5	static	1134139	686084.5
Storey4	static	1179529	694121.8
Storey3	static	1221512	698751.4
Storey2	static	1261018	700902.8
Storey1	static	1298987	701517.8



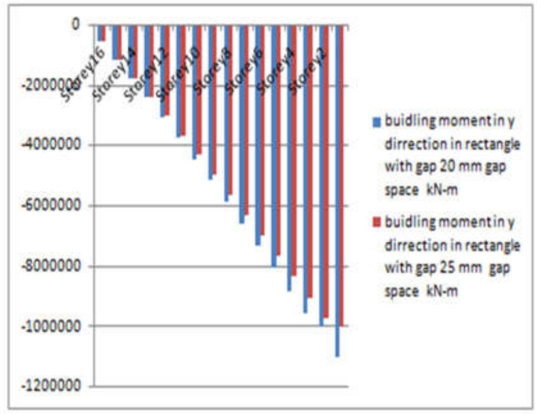
BUILDING MOMENT IN X DIRECTION

Storey	Load Case/Combo	BUILDING MOMENT IN X WITH RECTANGLE 20 mm gap space	BUILDING MOMENT IN X WITH RECTANGLE 25 mm gap space
		kN-m	kN-m
Storey16	static	579717.2	579789.6
Storey15	static	1159794	1159939
Storey14	static	1740232	1740449
Storey13	static	2321029	2321318
Storey12	static	2902186	2902548
Storey11	static	3483703	3484138
Storey10	static	4065580	4066087
Storey9	static	4647817	4648397
Storey8	static	5230415	5231066
Storey7	static	5813372	5814096
Storey6	static	6396689	6397486
Storey5	static	6980366	6981235
Storey4	static	7564403	7565345
Storey3	static	8148800	8149814
Storey2	static	8733558	8734644
Storey1	static	9339072	9340234



BUILDING MOMENT IN Y DIRECTION

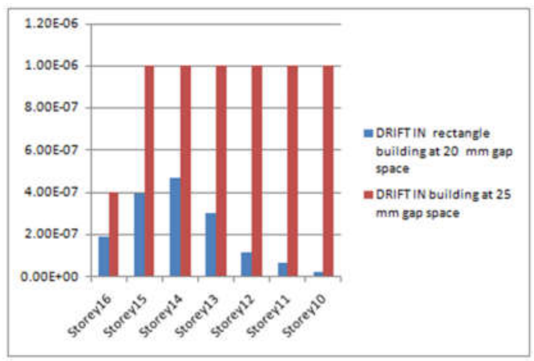
Storey	Load Case/Combo	building moment in y direction in rectangle with gap 20 mm gap space	building moment in y direction in rectangle with gap 25 mm gap space
		kN-m	kN-m
Storey16	static	-571814	-573716
Storey15	static	-1168019	-1165608
Storey14	static	-1786343	-1773402
Storey13	static	-2424669	-2394982
Storey12	static	-3081037	-3028386
Storey11	static	-3753640	-3671807
Storey10	static	-4440827	-4323594
Storey9	static	-5141100	-4982247
Storey8	static	-5853117	-5646426
Storey7	static	-6575692	-6314943
Storey6	static	-7307791	-6986765
Storey5	static	-8048538	-7661014
Storey4	static	-8797211	-8336968
Storey3	static	-9553240	-9014058
Storey2	static	-1.00E+07	-9691872
Storey1	static	-1.10E+07	-1.00E+07



TIME HISTORY RESULTS

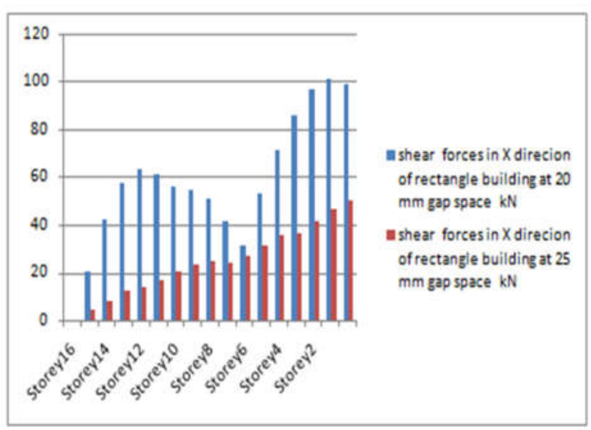
STOREY DRIFT

Storey	Load Case/Combo	DRIFT IN rectangle building at 20 mm gap space	DRIFT IN building at 25 mm gap space
Storey16	TH Max	1.93E-07	4.03E-07
Storey15	TH Max	3.96E-07	1.00E-06
Storey14	TH Max	4.68E-07	1.00E-06
Storey13	TH Max	3.05E-07	1.00E-06
Storey12	TH Max	1.15E-07	1.00E-06
Storey11	TH Max	6.82E-08	1.00E-06
Storey10	TH Max	2.72E-08	1.00E-06



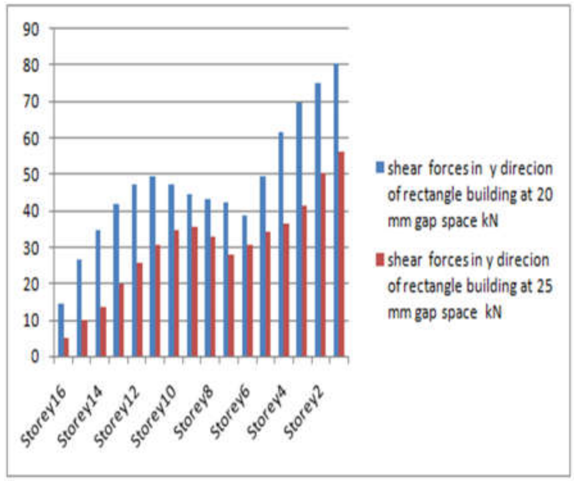
SHEAR FORCE IN X DIRECTION

Storey	Load Case/Combo	Location	shear forces in X direcion of rectangle building at 20 mm gap space	shear forces in X direcion of rectangle building at 25 mm gap space
			kN	kN
Storey16	TH Max	Bottom	20.2686	4.6685
Storey15	TH Max	Bottom	42.0085	8.3027
Storey14	TH Max	Bottom	57.7928	12.6333
Storey13	TH Max	Bottom	63.2766	14.006
Storey12	TH Max	Bottom	60.7368	16.7937
Storey11	TH Max	Bottom	56.3488	20.4214
Storey10	TH Max	Bottom	54.4139	23.2364
Storey9	TH Max	Bottom	50.7309	24.5614
Storey8	TH Max	Bottom	41.6884	24.1454
Storey7	TH Max	Bottom	30.9986	26.8799
Storey6	TH Max	Bottom	53.086	31.2671
Storey5	TH Max	Bottom	71.2224	35.3926
Storey4	TH Max	Bottom	86.1353	36.6389
Storey3	TH Max	Bottom	96.8996	41.1356
Storey2	TH Max	Bottom	100.88	46.3701
Storey1	TH Max	Bottom	99.0221	49.832



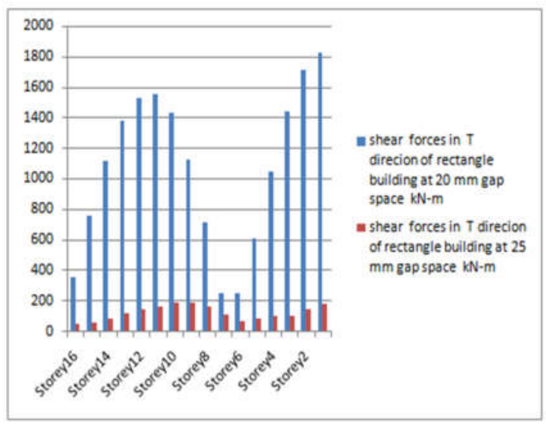
SHEAR FORCE IN Y DIRECTION

Storey	Load Case/Combo	Location	shear forces in y direction of rectangle building at 20 mm gap space	shear forces in y direction of rectangle building at 25 mm gap space
			kN	kN
Storey16	TH Max	Bottom	14.4866	5.06
Storey15	TH Max	Bottom	26.5944	10.1069
Storey14	TH Max	Bottom	34.6256	13.605
Storey13	TH Max	Bottom	41.7877	19.9258
Storey12	TH Max	Bottom	47.4318	25.4654
Storey11	TH Max	Bottom	49.3685	30.5306
Storey10	TH Max	Bottom	47.3451	34.4407
Storey9	TH Max	Bottom	44.4057	35.3778
Storey8	TH Max	Bottom	43.1187	32.6751
Storey7	TH Max	Bottom	42.1766	28.1132
Storey6	TH Max	Bottom	38.7797	30.378
Storey5	TH Max	Bottom	49.3841	34.0069
Storey4	TH Max	Bottom	61.6843	36.4666
Storey3	TH Max	Bottom	69.5672	41.5558
Storey2	TH Max	Bottom	75.1074	50.3445
Storey1	TH Max	Bottom	80.4349	56.2727



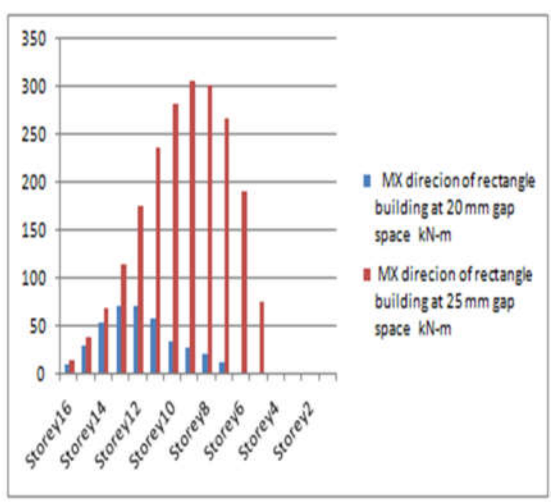
BUILDING TORSION

Storey	Load Case/Combo	Location	shear forces in T direcion of rectangle building at 20 mm gap space	shear forces in T direcion of rectangle building at 25 mm gap space
			kN-m	kN-m
Storey16	TH Max	Bottom	352.7836	40.3295
Storey15	TH Max	Bottom	754.1615	50.7339
Storey14	TH Max	Bottom	1114.141	81.1955
Storey13	TH Max	Bottom	1377.303	114.1255
Storey12	TH Max	Bottom	1524.883	136.9932
Storey11	TH Max	Bottom	1551.973	159.9307
Storey10	TH Max	Bottom	1425.709	185.9766
Storey9	TH Max	Bottom	1119.047	187.9382
Storey8	TH Max	Bottom	709.891	156.8787
Storey7	TH Max	Bottom	245.8408	108.7163
Storey6	TH Max	Bottom	243.1384	64.2708
Storey5	TH Max	Bottom	603.6755	80.5254
Storey4	TH Max	Bottom	1046.441	96.1672
Storey3	TH Max	Bottom	1442.164	96.8884
Storey2	TH Max	Bottom	1708.745	142.5719
Storey1	TH Max	Bottom	1825.645	175.5702



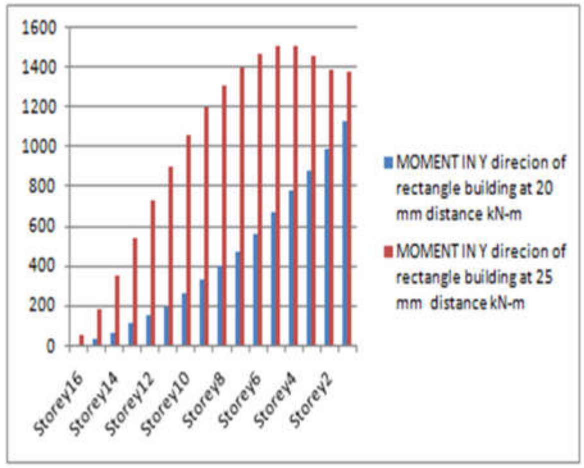
BUILDING MOMENT IN X DIRECTION

Storey	Load Case/Combo	Location	MX direcion of rectangle building at 20 mm gap space	MX direcion of rectangle building at 25 mm gap space
			kN-m	kN-m
Storey16	TH Max	Bottom	9.5704	14.234
Storey15	TH Max	Bottom	29.2642	38.2939
Storey14	TH Max	Bottom	53.0801	70.5625
Storey13	TH Max	Bottom	70.1008	116.206
Storey12	TH Max	Bottom	71.8352	175.022
Storey11	TH Max	Bottom	57.7652	235.872
Storey10	TH Max	Bottom	32.6946	283.217
Storey9	TH Max	Bottom	26.5906	306.956
Storey8	TH Max	Bottom	20.8733	303.154
Storey7	TH Max	Bottom	11.7173	267.072
Storey6	TH Max	Bottom	0.9827	191.79
Storey5	TH Max	Bottom	0	75.4029
Storey4	TH Max	Bottom	0	0
Storey3	TH Max	Bottom	0	0
Storey2	TH Max	Bottom	0	0
Storey1	TH Max	Bottom	0	0



BUILDING MOMENT IN Y DIRECTION

Storey	Load Case/Combo	Location	MOMENT IN Y direction of rectangle building at 20 mm distance	MOMENT IN Y direction of rectangle building at 25 mm distance
			kN-m	kN-m
Storey16	TH Max	Bottom	14.0054	60.8059
Storey15	TH Max	Bottom	35.1032	186.8313
Storey14	TH Max	Bottom	72.723	360.2097
Storey13	TH Max	Bottom	114.741	550.0395
Storey12	TH Max	Bottom	155.4575	732.2499
Storey11	TH Max	Bottom	199.3695	901.2962
Storey10	TH Max	Bottom	264.3168	1058.689
Storey9	TH Max	Bottom	338.001	1199.073
Storey8	TH Max	Bottom	410.3602	1313.891
Storey7	TH Max	Bottom	478.3463	1401.803
Storey6	TH Max	Bottom	565.9343	1467.091
Storey5	TH Max	Bottom	672.1119	1506.4
Storey4	TH Max	Bottom	782.0286	1506.766
Storey3	TH Max	Bottom	888.8852	1463.512
Storey2	TH Max	Bottom	995.5781	1391.526
Storey1	TH Max	Bottom	1128.349	1384.574



V.CONCLUSIONS

- Pounding of the structures produce impact loads which are superimpose on those caused by the ground acceleration. When the impact loads from pounding of the structures are too high, the structural system has to be modified to reduce the response.
- While designing the buildings pounding must be checked to avoid the damages
- If the buildings are in planning stage the easiest way to avoid pounding is to provide the safe separation distance between buildings as given by code
- Safe separation distance according to FEMA –273 is 20 mm for the case understudy which is greater than the maximum out of phase movement between buildings. It means that FEMA-273 give the conservative results
- For retrofitting of existing buildings three efficient and cost effective mitigation measures are assessed to avoid pounding induced collapse of buildings. Use of shear wall, bracing system and friction dampers are proposed as possible mitigation techniques. All the three mitigation strategies are proved to be effective to avoid the damage in the buildings because of the pounding effects.
- In this study, it is concluded that constructing adjacent buildings with equal floor heights and separation distances reduces the effects of pounding considerably.
- The duration of strong motion increases with an increase of magnitude of ground motion
- The separation distance between the two structures decreases, the amount of impact is increases, which is not applicable in all cases. It is only applicable when the impact time is same. It may also decreases when separation distance decreases, which leads to less impact time.
- by all above results it is concluded that the building with 25 mm gap was having less drift values (total displacement) so the effect of the buildings is best when minimum space should be 25 mm in order to reduce the seismic pounding effect in the buildings .

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